

*File: Delay Action for Silicone
Timing Device, Plastic Film*

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In replying please address:

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*DELAY ACTION FOR SILICONE
TIMING DEVICE PROPOSAL*

November 28, 1956

Dear Sir:

Enclosed is a proposal describing a research program directed toward the further development of a silicone putty time-delay mechanism which has been evolved by another of your contractors. The proposed research program is based on recent discussions with your technical representatives.

During the course of prior research, we have considered the extrusion of silicone putty as a basis for measuring time. Although there are few physical-property data available relative to silicone putty, we believe that this material is particularly applicable to a timing device such as the unit of interest to you. We are confident that the present silicone putty time-delay mechanism can be developed into an inexpensive practical device.

If you should have any questions regarding our proposal, please let us know. Any inquiries of a contractual nature may be directed to

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Very truly yours,

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Acting Director

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In Duplicate

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PROPOSED RESEARCH PROGRAM

on

THE FURTHER DEVELOPMENT OF A SILICONE PUTTY TIME-DELAY MECHANISM

Introduction

During the past several years, the search by many organizations for a cheap, reliable, and reasonably accurate time-delay mechanism has led to the consideration of silicone putty as a timing medium. A device of this type has already been developed by one of the Sponsor's contractors. In this unit, a spring-loaded piston forces silicone putty through an orifice and advances until a spring-loaded firing pin is released. The release time is established primarily by the size of the orifice and by the spring force acting on the piston. However, because temperature affects the viscosity and volume of the silicone putty, the time of release is also affected by these characteristics of the material. Unfortunately, published data on silicone putty are scarce and, therefore, suitable design parameters have not been established. The silicone putty timing device, in its present form, is inadequate, but it is believed that compensation for the above-indicated variables can be devised after the type and amount of variations have been established.

The following specifications are goals for the device of interest:

- (1) It should have a high degree of reliability,
of the order of 99 per cent.
- (2) It should be accurate to within $\pm$ 10 per cent
of the time setting.

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- (3) It should retain its accuracy over a temperature range of -20 to +120 F.
- (4) It should have an adjustable time setting ranging from 15 minutes to 2 months; this range may be achieved by using two interchangeable timing heads, if necessary.
- (5) It should not weigh more than 1/2 pound.
- (6) It should not cost more than \$5 to \$10 in production lots of 10,000.
- (7) It should not be larger than 1 inch in diameter and 4 inches in length.

Objective

The objective of the proposed program would be to conduct research directed toward the further development of the above-described silicone putty time-delay device in an attempt to satisfy the specifications outlined above.

If, as expected, the results of the proposed research were favorable, up to 6 prototypes of the device would be fabricated experimentally, and a set of production drawings and specifications and an operator's manual would be prepared.

General Procedure

Although it is reasonably certain that few data on the pertinent physical characteristics of silicone putty are presently available, a limited

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literature search would be made to establish the validity of this belief. Also, companies known to manufacture silicone putty would be contacted for information and a supply of silicone putty would be purchased. The device in its present form would be evaluated to determine its general performance, particularly under extreme temperature conditions.

As soon as the results of the search for pertinent information were available, experiments would be conducted to obtain certain basic data on silicone putty that were expected to be useful in the further development of the device. It is believed that information of potential value includes data on the viscosity of silicone putty, the effect of temperature and pressure on viscosity, the coefficient of volumetric expansion, and the linearity of this coefficient as a function of temperature. Silicone putty is known to be quite stable; therefore, it appears unnecessary to investigate its aging properties. It would be desirable, however, to determine how its basic properties might be affected by composition. It is emphasized that the currently contemplated experiments directed toward establishing useful data on selected physical properties of silicone putty would be simple and short term. Further, it is expected that, by the end of approximately the first month of the proposed research period, considerable pertinent data would be available on the inherent physical properties of silicone putty, for application to the time-delay-device problem.

Idea conferences would be held to consider the problems associated with temperature compensation and variable timing in the type of device of interest. Several ideas which might be useful have already been conceived. For

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example, if the clearance between the piston and its cylinder were to serve as the orifice, the selection of proper materials for the piston and the cylinder might, in effect, cause the orifice size to vary as a function of temperature and might provide sufficient compensation.

If two timing heads for the device were considered in order to cover the desired range of 15 minutes to 2 months, the adjustable time variation would, of necessity, be approximately 80:1; one head would be used to cover periods from 15 minutes to 20 hours, and the other, periods from 20 hours to 2 months. However, provision of an 80:1 change in force without considerable sacrifice in accuracy, especially for long-time settings, does not appear too promising. Consequently, the desired variation in time could probably be achieved best by means of a variable orifice. Further, in the interest of space and weight savings, the piston stroke should be kept to a minimum.

It is currently contemplated that a small number of experimental timing heads, perhaps up to 12, would be prepared to facilitate laboratory evaluation of some of the ideas resulting from the idea conferences. These units would be prepared to cover the short time range, to minimize the elapsed time required to establish their accuracy. It appears that at least six experiments should be run to evaluate reproducibility under each condition of interest. The investigation of three time settings and two temperature extremes should suffice for the evaluation of a given experimental device. As a result of these studies, several modifications would probably be required. At this stage of the proposed research, it is contemplated that the design of an experimental prototype of a short-time-range head would be started.

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While this prototype was being designed, the previously mentioned experimental timing heads would be modified to serve as long-time-range units and then evaluated under experimental conditions involving a 2-month time setting and the above-indicated temperature extremes. On the basis of the data obtained from these studies, an experimental unit intended to represent a prototype of a long-time-range head would be designed.

If, as expected, the results were favorable, the next step in the proposed research program would consist of preparing up to 6 experimental prototypes of the modified time-delay mechanism. These units would incorporate the experimental timing heads evolved during the proposed program and the firing mechanism which has already been developed by another of the Sponsor's contractors.

The experimental prototypes of the modified time-delay mechanisms would be evaluated in the laboratory as short-time-range devices. Experiments would be made to evaluate the accuracy of the device under extreme temperature conditions for at least three time settings. When these were concluded, long-time-range experiments would be initiated. Concurrently, it is expected that the preparation of production drawings and specifications (if justified by the results) and of an operator's manual would be started.

It is likely that modifications required at this time for the prototype of both the short- and the long-time-range head would be minor in nature and could probably be safely incorporated in the experimental units and in the production drawings and specifications without further laboratory evaluation.

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The appropriate changes would be made, and the experimental prototypes, the drawings and specifications, and the operator's manual would be submitted to the Sponsor.

Experience and Facilities

Members of our Rubber and Plastics Chemistry Division and Mechanical Engineering Division have, in recent years, had experience with silicone putty from the standpoint of interest in the physical properties and/or potential applications. This, coupled with their general background of experience, would be of value in conducting the proposed research program.

Reports

Monthly letter reports would be prepared to keep the Sponsor informed of the progress of the research. These would be supplemented by meetings with the Sponsor. At the conclusion of the proposed research period, a summary report would be prepared and submitted, along with a set of production drawings and specifications (if justified by the results), and an operator's manual.

Duration and Costs

It is proposed that the contract provide for a seven-month period of research, with an estimated appropriation of \$18,550, including the fixed fee. The general breakdown of the estimated costs is attached.

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The Contract

The proposed contract would be a period-basis research agreement, consistent with our current contractual arrangements and providing only for a fixed period of research leading toward the objective outlined in this proposal.

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[redacted] to the U. S. Government,
For Research on **The Further Development of a Silicone Putty Time-Delay Mechanism.**

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Based upon a period-basis Contract for a research period of **seven months.**

(Including time for submission of all reports. The proposed contract will not provide for earlier conclusion of the research.)

ESTIMATED COSTS

We expect that the cost of this research for the period indicated above may be distributed approximately as set forth hereon, subject to the understanding that this allocation is merely an estimate, and actual costs incurred may vary from the categories shown. We have determined that these estimates are reasonable and consistent with [redacted] established policies in its research for the various Government agencies, which policies are briefly discussed below and will be followed in determination of our actual costs hereunder.

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Materials & Supplies, etc.

\$ 1,000

(Including any equipment which may be purchased as necessary in performance of the research. Charges of \$25 or less are excluded from this item.)

Use of Equipment and Technical Services, Travel, and Misc.

\$ 2,100

(Including applicable costs of technical research and service divisions, and use of technical equipment, except that any undistributed balances of these accounts will be included in overhead. Cost of travel includes reasonable actual subsistence expenses and the actual cost of transportation. An allowance of up to 7¢ per mile for all necessary travel by privately owned conveyance is included in lieu of the cost of such travel.)

Salaries & Wages

(Including our predetermined accrual for vacation, holiday, and sick-leave pay, pensions, and social security.)

Type of Employee	No. of Man-Months	Estimated Cost
Supervision	1	\$ 1,000
Research Engineers	8	5,520
Lab. Assistants	7	2,800
Steno., Clerical, Shop & Photo., etc.	1	280
Total Salaries & Wages		\$ 9,600

Overhead

(52 per cent [or such other provisional rate as may from time to time be mutually agreed upon with the Government's audit representatives] of salaries and wages, as they are defined above. This is a provisional rate for current reimbursement, which we have arrived at by negotiation with Government representatives, and it will be subject to retroactive revision to the "actual" rate agreed upon with them for each calendar year following a detailed audit for that year. The item of overhead includes general research, charges of \$25 or less for materials and supplies, and other categories of costs we customarily include in our overhead account. Cash discounts on all purchases will be credited to overhead, instead of to the amount of the purchase. Scrap of appreciable value will be credited directly to the project. All other scrap will be credited to the overhead account, in which the Government participates.)

\$ 4,800

Total Estimated Cost

\$ 17,500

Fixed Fee

1,050

Contract Price

\$ 18,550

Please let us have your acceptance in our hands by **January 15, 1957.**
Unless we extend the time, your acceptance after that date will be subject to agreement.

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